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Chernobyl's Effects on the Perceived Risks of Nuclear Power: A Small Sample Test

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This paper presents the results of two risk perception surveys, one taken just before and one just after the accident at Chernobyl in May, 1985. The results show that Chernobyl affected short-term perceptions of nuclear power risks in ways that are predictable and measureable. In this sample, perceived levels of dread of nuclear power increased, perceived knowledge increased, and perceived severity decreased. Overall, the results are informative about how a single event could affect perceived risk characteristics.

KEY WORDS: Risk perception; Chernobyl.

1. INTRODUCTION

The events at Chernobyl in April, 1986 must rank high on any list of the world's worst technological disasters. But surely Chernobyl would top a list based on the criterion of worldwide media attention. Hundreds of millions of people watched the saga unfold on television screens and in print, with emotions ranging from curiosity to terror. The social "fallout" from Chernobyl has not been measured; we do not yet know how attitudes toward nuclear energy, or toward all complex technology, will be affected by the incident. Some observers think that Chernobyl's effects will be drastic.[3]

It is surprising that little work has been published on how public perception of nuclear technology has been affected by Chernobyl. This gap is not due to a lack of tools or previous groundwork. The risk perception paradigm developed in the work of Slovic, Fischhoff, and Lichtenstein, as well as others, employs psychometric scaling techniques to measure how people perceive various hazards in terms of their underlying characteristics (see Ref. 2 for an overview of various applications of the risk perception scaling approach). For example, nuclear power is typically viewed as an extreme example of a technology where risks are highly dreaded, not well known, severe, uncontrollable, and involuntary. This paradigm is a useful approach to documenting in a relatively simple manner people's perceptions of a given hazard or technology, between groups and over time.

This paper reports the results of two risk perception surveys administered within a single population, undertaken as part of a larger research project. Thanks to serendipity, the first survey was undertaken just before the Chernobyl incident, in early

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[3]In his 1986 address to the Society for Risk Analysis, H. Otway admonished, "Do not underestimate the effects of Chernobyl. It will change forever the relationship between laypeople and experts."(1)

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April, 1986, while the second, larger survey was undertaken shortly after it, in late May, 1986. Examined together, the two surveys provide quantitative evidence of how perceptions of nuclear power within a given population were affected by Chernobyl, over the short term.

This paper is of interest for three reasons: First, even though the sample sizes in the surveys are small, they provide evidence that Chernobyl affected attitudes in this population in predictable ways. Second, this is perhaps the first examination of how a single event could affect perceptions of risk.[3] Third, this paper provides some modest insight into how new information could alter peoples' perceptions of a technology. Thus, it is relevant to research regarding the efficacy of risk communication efforts.

2. EXPERIMENT

The two surveys were part of a series of surveys administered in a larger study of the relationships between risk perceptions and subjects' expressed preferences for improved safety. The survey instrument contained a number of contingent valuation questions[4] and a set of risk perception psychometric scales; both kinds of questions dealt with ten risk items, five well defined (for which the annual average number of deaths in the United States from each risk is known) and five less well defined (for which annual average number of deaths in the United States cannot be stated with precision).[5] Brief descriptions of the ten risks, including the number of annual deaths from each well-defined risk, were included in the questionnaire. A complete text of the survey instrument is presented in Ref. 4.

The risk perception scales employed in the surveys were identical to those employed by Slovic, Fischhoff, and Lichtenstein.[2] Subjects rated each risk on seven-point scales for a series of attributes that are commonly used to characterize risks. An example is presented below.

Not Dread – Dread. Is this a risk that people have learned to live with and can think about reasonably calmly, or is it one that people have great dread for—on the level of a gut reaction?

Not Dread 1 2 3 4 5 6 7 Dread

The seven risk attributes employed in the two surveys to characterize the hazard set included: voluntariness, severity, control, knowledge, dread, public exposure, and overall risk. In addition, the second survey included another attribute, personal exposure. Wording for each attribute question was similar or identical to that in Slovic, Fischhoff, and Lichtenstein's work.[2] Subjects rated the whole set of hazards on a given attribute before proceeding to the next characteristic.

The first survey was initially intended to be administered to a number of subject groups. However, comments received after the first survey's administration prompted some minor revisions to the instructions for the contingent evaluation questions. Thus, the first survey was administered to only one subject group. The risk perception questions and all relevant instructions were identical on the two surveys, except for the addition of the personal exposure attribute on the second survey. For the comparisons outlined below, the two survey instruments can be viewed as identical.

3. SAMPLES

Survey 1 was administered to a group of graduate students in a midcareer program in public management at Carnegie Mellon University in Pittsburgh ($n = 22$). The questionnaires were completed in class, and all students participated. Subjects' modal age category was between 35 and 45 years old; the modal household income category was $30,000–$45,000. These subjects were likely above average in education, although no data were collected.

Survey 2 was administered to four groups of adults in Pittsburgh. In total, 55 complete, usable questionnaires were obtained; all subjects were given the same questionnaire. The four groups included a different set of students in the same graduate midcareer public management program ($n = 19$), parents of children attending a daycare center and workers at the center ($n = 20$), professionals and clerical staff in

[4] "Contingent valuation" is a technique to evaluate nonmarket goods, such as safety or environmental quality. The question forms and the questionnaire's overall results are reported in Ref. (4).

[5] The complete set of well-defined risks included automobiles, aviation, a workplace chemical (VCM), power tools, and LNG/LPG. The complete set of less well-defined risks included chlorinated water, hazardous waste, nuclear energy, sulfur air pollution, and electromagnetic fields.

the office of an economics consulting firm ($n = 10$), and residents of middle class neighborhood ($n = 6$). In the latter three groups, participants were self-selected in that questionnaires were distributed, completed by those who wanted to participate, and returned.[6] In the group of midcareer students, the questionnaires were completed in class, and all participated.

The socioeconomic characteristics of Survey 2 subjects were mixed. All subjects were over age 25, with the modal age category being between 25 and 35. The modal household income category was $30,000–$45,000 annually. Again, it seems likely that the subjects were, on average, highly educated, although no data were collected. Three of the groups contained at least one professional with active interest in risk analysis.

Survey 1 subjects and those in the midcareer graduate student group of Survey 2 can essentially be viewed as two draws from the same population. In terms of socioeconomic characteristics and basic attitudes, that population is likely similar to the Action club subject group in Slovic et al.'s earlier risk perception studies.[2]

4. EXPECTATIONS

Judging from reaction to the Three Mile Island incident, one might expect that a nuclear disaster on the scale of Chernobyl, so widely publicized, would affect subjects' perceptions of nuclear power in predictable ways. Specifically, it seems likely that the perceived level of dread held by the public would increase. Perceived knowledge of the hazard on the part of those at risk would also increase, because of the wide media attention. The perceived severity, in terms of the certainty of fatalities, could go up or down, depending on whether the outcome of Chernobyl was as severe as had been subjectively supposed for an accident of that magnitude. Overall risk to the general public could similarly go up or down. Voluntariness, controllability, and public exposure are probably less likely to be affected because little new information or awareness regarding these characteristics would likely be derived from the Chernobyl experience.

5. RESULTS

The following discussion will primarily be concerned with comparison between the midcareer student responses of Survey 1 and the comparable group in Survey 2. In addition, results will be reported for the whole sample in Survey 2 to provide a broader comparison. Our focus is on comparing their responses for nuclear power.

Table I shows the mean responses for subjects' perceptions of nuclear power, for the seven risk perception scales in the two surveys, and their standard deviations. Columns 1 and 2 present results for Survey 1, columns 3 and 4 present results for the graduate student group of Survey 2, and columns 5 and 6 present results for all four groups of Survey 2.

Comparing columns 1 and 3, one sees that within the student group, the directions of the sign changes

[6]The numbers of questionnaires distributed were as follows: daycare, 84; consulting firm, 11; neighborhood, 10; midcareer students, 20. Thus, 24% of the questionnaires distributed at the daycare, 91% of the questionnaires distributed at the consulting firm, 60% of the questionnaires distributed in the neighborhood, and 95% of the questionnaires distributed to the midcareer students were actually employed in the analysis.

Table I. Nuclear Power Risk Perception Responses, Surveys 1 and 2

	Survey 1 ($n = 22$)		Survey 2 students only ($n = 19$)		Survey 2 total sample ($n = 55$)	
Risk characteristics	(1) Mean	(2) Standard deviation	(3) Mean	(4) Standard deviation	(5) Mean	(6) Standard deviation
Voluntariness	5.81	1.07	5.68	1.45	5.69	1.52
Severity	5.52	1.66	4.84	2.00	4.71	2.00
Knowledge	4.86	1.48	4.21	1.79	4.78	1.65
Control	2.59	1.82	2.74	2.04	2.49	1.83
Dread	5.36	1.22	5.84	1.49	5.96	1.46
Public exposure	4.63	1.72	4.68	1.48	4.60	1.73
Overall risk	4.00	1.97	4.36	2.13	3.92	2.23

for the means map well onto the expectations outlined earlier. Specifically, the level of perceived public Dread of the nuclear power *increased* by 0.48 on a scale of 7. The mean for the Knowledge scale changed by −0.65, indicating an *increase* in the perceived extent to which the risks are known to those exposed.[7] (The change in Knowledge is much smaller when comparing column 1 to column 5, the mean for the total sample in Survey 2.) In contrast, the mean perceived Severity *decreased* by 0.68, indicating that Survey 2 subjects believed that the results of a nuclear mishap are *less* certain to be fatal than Survey 1 subjects. This result is in keeping with the fact that relatively few deaths had been documented from Chernobyl when Survey 2 was taken in May, 1986. Perceived Overall Risk of death from nuclear technology was sightly higher for the Survey 2 students (slightly lower for the total sample of Survey 2). The Voluntariness, Control, and Public Exposure ratings were virtually unchanged.

Wilcoxon rank sum tests[5] were used to test for differences between the distributions of responses for each scale between survey groups. The small samples of the tests yield low statistical power. Consequently, none of the comparisons between the two distributions yields decisive results. Comparing Dread for Survey 1 and the students of Survey 2, the Wilcoxon test for differences in the distributions yielded a $p = 0.06$, meaning that the null hypothesis of equivalence between the means is rejected at the 94% confidence level. For Knowledge in the same two groups, the null hypothesis is rejected at the 85% confidence level ($p = 0.15$). Neither is a resounding statistical difference, but given the small samples, both are plausible.

Comparing Survey 1 responses to the total sample of Survey 2, the Wilcoxon test for differences in the distribution of the Dread characteristic yield a $p = 0.05$, giving a 95% confidence level for rejecting the null hypothesis.

6. DISCUSSION

At least in these samples, Chernobyl affected the public's perceived risks of nuclear power in ways that are both plausible and measurable. Although hampered by the small sample sizes, tests show statistical differences between the samples that are acceptably conclusive for the Dread characteristic. Perhaps more relevant is that the directions of the changes for perceived Dread, Knowledge, and Severity largely agree with the expectations outlined earlier. It is interesting to note that the results show increases in perceived Dread concurrent with decreases in perceived Severity after Chernobyl. Previous factor analyses of risk perception responses across a wide range of hazards generally show that the Dread and Severity characteristics have strong communality and are typically represented by the same factor.[2] In some sense, it has been thought that they measure the same thing. Here, we see new information increasing Dread, but decreasing Severity. It may be that nuclear power is unique in that the expected near term deaths from even a major incident are apparently low compared to, say, automobile accidents; yet nuclear power is very highly dreaded.

Slovic[3] has indicated that recent replications of their earlier work on risk perception have generally shown that subjects perceive that there is a greater level of knowledge of nuclear power risks, on the part of those exposed, than was shown in the 1970s surveys. Comparison of the two student samples would suggest that Chernobyl may have reinforced that trend, or was perhaps a major source of change.

More broadly, these results show that a single event, albeit one with the import of Chernobyl, can alter perceived characteristics of the risks of a technology, at least in the short term. On the other hand, one might wonder why more change was not evident in the ratings, since the survey followed so closely after the disaster. A number of answers can be considered. First, risk perception scale responses have been shown to be remarkably stable across groups and over time.[2] Thus, any noticeable change merits attention. Another possibility is that the rating scales are not fine enough to pick up subtle changes at the margin. Also, the small sample size may limit the ability to pick up changes that would be apparent in larger samples. Finally, it may be that Chernobyl did not change peoples' attitudes from indifference to great fear of nuclear power. Rather, the incident may simply have reinforced existing attitudes, meaning only slight changes in mean ratings would occur.

Ultimately, more extensive long-term research will be needed before we can judge the full effect of Chernobyl on public risk perceptions and how those perceptions affect the acceptability of nuclear power.

[7]That is, Knowledge was scaled so that 1 indicated high knowledge, and 7 indicated low knowledge. A decrease in the mean indicated greater knowledge, on average.

Until then, regulatory bodies will likely continue to act as though nuclear power has become even less palatable to the general public. Depending on how one interprets the changes in perceptions presented here, one could find either support or contradiction of that assumption.

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